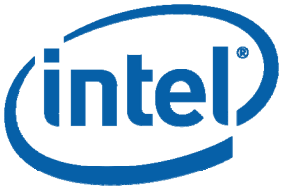

Intel® Thread Checker for Windows*

Getting Started Guide

Intel® Thread Checker detects data races, deadlocks, stalls, and other threading issues. It can detect the potential for these errors even if the error does not occur during an analysis session. Use Thread Checker to filter out specific types of diagnostics, identify critical source locations, and get tips to improve the robustness of your parallel software.

Overview

This guide presents a threaded code example and teaches you how to use Intel® Thread Checker to identify and handle threading-related issues. After completing this guide, you should be ready to analyze and repair your own code using Thread Checker.

To quickly start using Thread Checker, print this short guide and walk through the example provided.

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Disclaimer and Legal Information

Revision History

Document Number	Revision Number	Description	Revision Date
	001	Initial release.	2005
313031	030	Updated for product 3.0 release. Applied new template.	April 2006

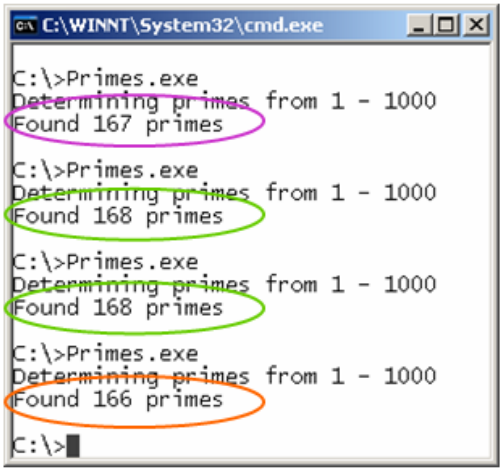
1 Build the Sample Code

The `Primes` sample code identifies and tallies the prime numbers in the range from one to 1,000. Using the Windows* threading APIs, multiple threads perform the work. However, the threads simultaneously access the same memory location, causing potential data races. As a result, this program may generate incorrect results.

1. Open the `Primes.dsw` project workspace file in Microsoft* Visual Studio. By default, this project is installed with the Intel® Thread Checker in: `C:\Program Files\Intel\VTune\tcheck\Samples\Primes`.
2. Build the `Primes.dsw` project.
   This sample project is set up to include the following options: `"/Zi"` to include symbols, `"/Od"` to disable optimization, linked `"/fixed:no"` to make code relocatable, and `"MDd"` or `"MTd"` to build with thread-safe run-time libraries. These options are required to enable Thread Checker to provide you with the most detailed information, including variable names and line numbers associated with errors.

TIP: See Thread Checker **Help** for more hints on options and building applications.

If you run the `Primes.exe` program several times from the command prompt you might see output such as the following:



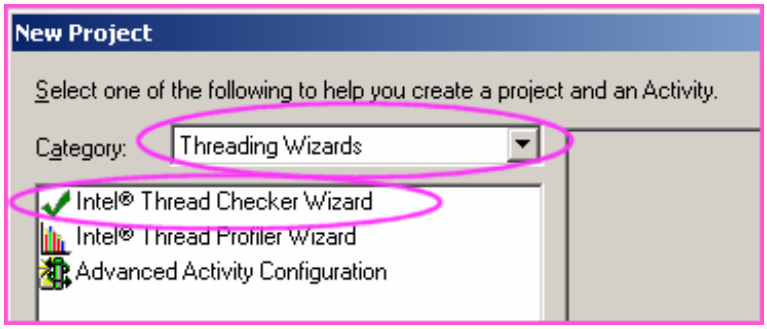
What do you see? Different runs produce inconsistent results! The correct result is "`Found 168 primes`". In this case, it is relatively easy to see that there is a threading inconsistency. In larger programs, a threading inconsistency can be much harder to see.

Thread Checker can help you locate the threading inconsistency.

2 Collect Data

You use the **Intel® Thread Checker Wizard** to create a project and an Activity and collect data on the `Primes.exe` image.

1. Double-click the **Intel® VTune™ Performance Analyzer** shortcut icon on your desktop to start the VTune™ Analyzer with the Intel® Thread Checker plug-in:
2. In the **Easy Start** dialog box that opens, or from the main toolbar, click the **New Project** button .
3. In the **Category** drop-down box, choose **Threading Wizards**.
4. Select **Intel® Thread Checker Wizard** as shown:



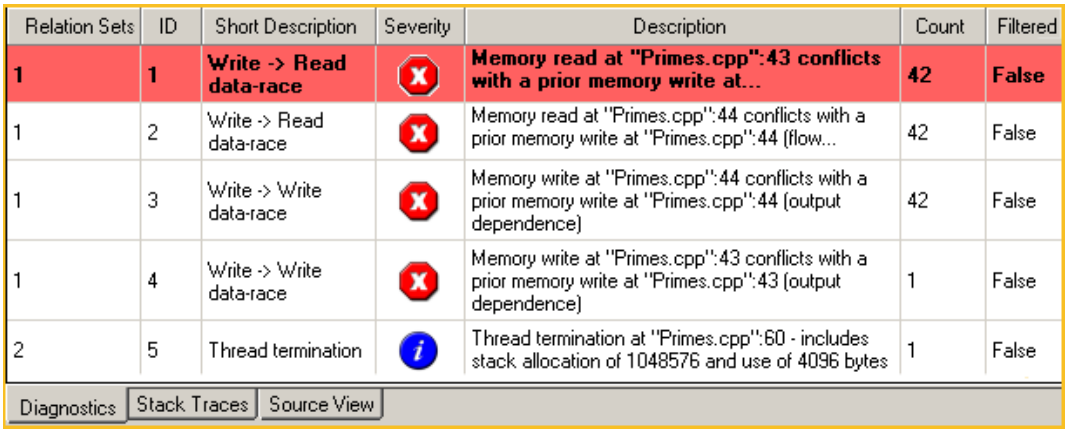
5. Enter a **Project Name**, for example, `PrimesProject`.
   Thread Checker fills in a default for the **Project Location** directory that you can change if required.
6. Click **OK**. The **Intel® Thread Checker Wizard** opens.
7. Under **Launch an application**, click **[...]** to navigate to the `Primes.exe` you built. If you followed default settings, it is located in `C:\Program Files\Intel\VTune\tcheck\Samples\Primes\Debug\Primes.exe`
   For all other options, you can use default values.
8. Click **Finish** to complete the wizard.
   Thread Checker instruments your application, executes it, collects data, and displays the results in the **Diagnostics** list.

By default, the option **Update diagnostics while the Activity is running** is selected. During the Activity run, Thread Checker announces the arrival of new diagnostics. This feature is useful for long running applications.

Now you can use Thread Checker to identify threading issues.

3 Analyze Results and Correct the Code

After completing the wizard, you should see results similar to the following:



Relation Sets	ID	Short Description	Severity	Description	Count	Filtered
1	**1**	**Write -> Read data-race**		**Memory read at "Primes.cpp":43 conflicts with a prior memory write at...**	**42**	**False**
1	2	Write -> Read data-race		Memory read at "Primes.cpp":44 conflicts with a prior memory write at "Primes.cpp":44 (flow...	42	False
1	3	Write -> Write data-race		Memory write at "Primes.cpp":44 conflicts with a prior memory write at "Primes.cpp":44 (output dependence)	42	False
1	4	Write -> Write data-race		Memory write at "Primes.cpp":43 conflicts with a prior memory write at "Primes.cpp":43 (output dependence)	1	False
2	5	Thread termination		Thread termination at "Primes.cpp":60 - includes stack allocation of 1048576 and use of 4096 bytes	1	False

Diagnostics | Stack Traces | Source View

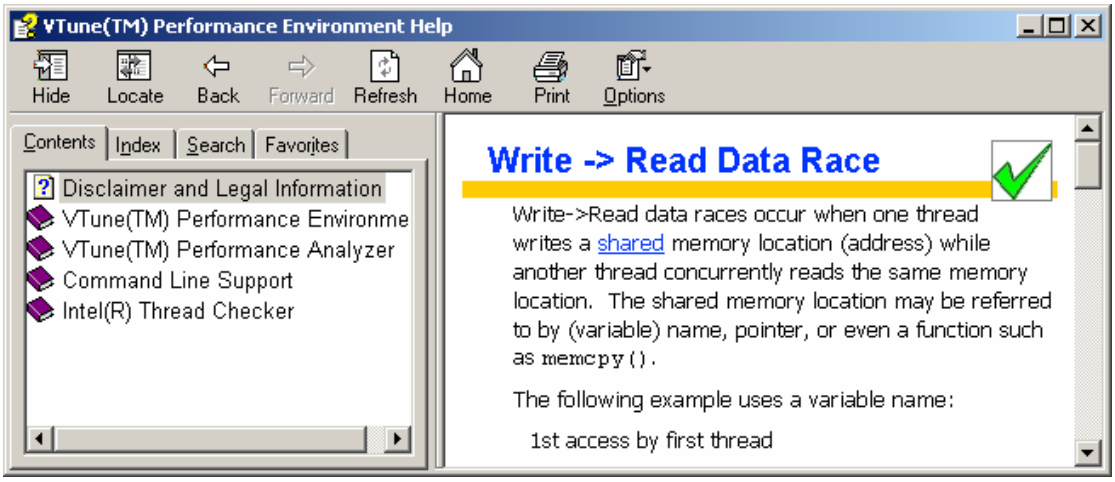
Figure 1: Intel(R) Thread Checker displays results in the Diagnostics **view.**

Congratulations! You are now ready to analyze diagnostics and correct threading inconsistencies in the application.

NOTE: If you do not see results, open ***Help*** > ***Search*** and search for ***"Troubleshooting Thread Checker"*** for possible causes and solutions.

Look at the first diagnostic in the list, highlighted in red and identified by ID 1. Thread Checker identified a **Write -> Read data-race** error. This error, indicated by a red stoplight icon, , is caused by shared memory variable accesses that are not properly synchronized.

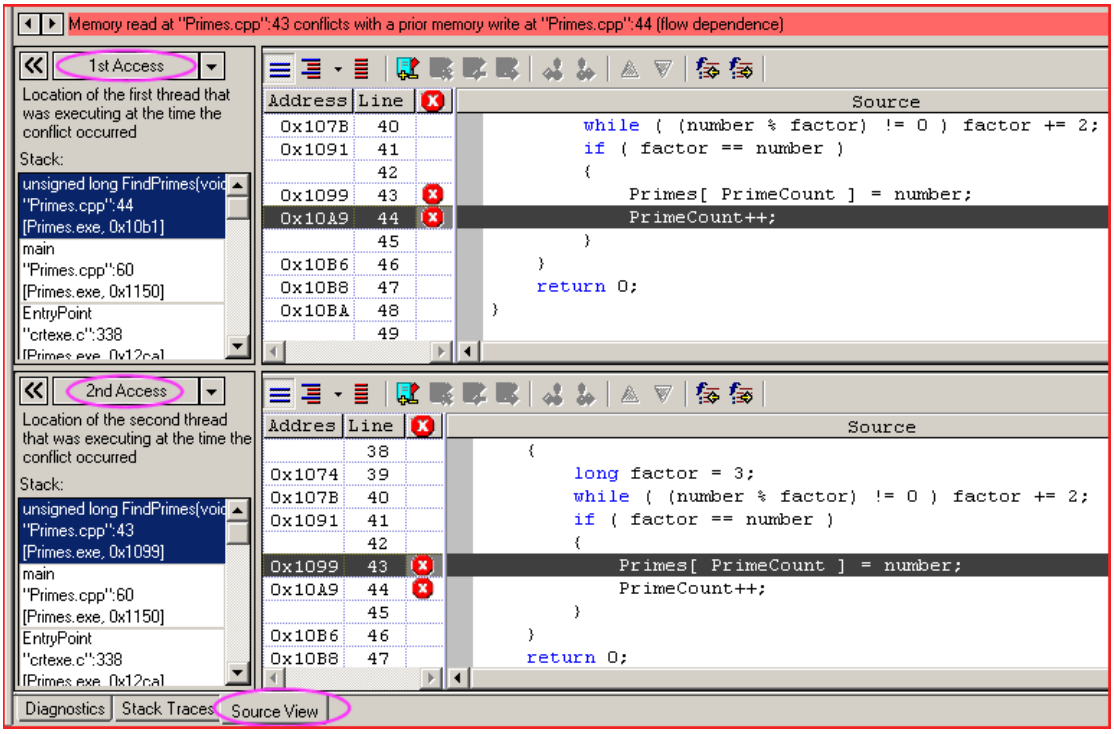
Right-click the first row in the diagnostic list and select **Diagnostic Help** from the pop-up menu. A **Help** topic opens, showing explanations of the diagnostic, its causes, and possible solutions to help you fix your code.



Write->Read data races occur when one thread writes a shared memory location (address) while another thread concurrently reads the same memory location, causing a conflict.

NOTE: Diagnostics with a similar context are grouped together in the same **Relation Set**. To see the contexts used, right click on the grid and select **Show Column > Context > Context[Best]**.

To locate the conflict in the source, click the **Source View** tab. On top, the **1st Access** pane shows the source location where the previous thread wrote to the shared memory location. In this case, at **line 44**. On bottom, the **2nd Access** pane shows the source location where the unsynchronized memory read of the shared memory location occurred, in this case at **line 43**:



Resolve conflicts and test results

Try adding a `CRITICAL_SECTION` to correct the source code. By adding a synchronization object to serialize the use of `Primes[]` and `PrimeCount` (lines 43 and 44), you can eliminate the inconsistent and incorrect effects of time sliced multi-threading.

To verify that the **Write -> Read data-race** identified by Thread Checker is indeed fixed, repeat the steps you followed above:

1. Build the modified code.
2. Collect data on the modified `Primes.exe` by pressing the **F5** key, or by clicking the Run Activity button  .
3. Analyze results.

How did you do? If you resolved all the data races, you should see results with only informational diagnostics indicated by a blue icon,  .

NOTE: View the code provided in `PrimesFixed.cpp` for a solution to the data race conflicts. You can also build this code using the `PrimesFixed.dsw` project and analyze the `PrimesFixed.exe` within Thread Checker to confirm that the data races are in fact fixed.

4 Next Steps

To get the most out of Thread Checker, explore the following resources:

- **Online Help** is the product's complete user's guide. Use **Help** to learn about additional features, including remote data collection and other advanced options. Open **Help** by pressing the **F1** key.
- **Samples** provide additional code examples for you to explore. Use them to learn to identify and resolve other types of threading errors.
  Find code **Samples** in the `tcheck\Samples` folder. Read the associated ***Guide to Sample Code***, `CodeExamplesGuide.pdf`, available in the `tcheck\Doc` folder.
- **Release Notes** include key product details. See the Release Notes for updated information on requirements, technical support, and known limitations.
  Open **Release Notes** from (for example) **Start > Programs > Intel(R) Software Development Tools > Intel(R) Thread Checker > Intel(R) Thread Checker Release Notes**.
- **Intel® Thread Profiler**. After you check your code with Intel® Thread Checker, use the **Intel® Thread Profiler** to help you improve its performance.
  Find details about Thread Profiler and other Intel software development products at: http://www.intel.com/software/products/.